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## THE RELATION OF A STATE GEOLOGICAL SURVEY TO THE WORK OF THE NATIONAL SURVEY.

BY A. H. THOMPSON, TOPEKA.

In view of the facts that the United States Topographical and Geological Survey has extended its work to include the entire national domain, and that its scientific operations are much better executed than can ever be accomplished by any State organization alone, it was deemed advisable by some of the members of the Academy that some correspondence should be had with the directors of the national survey, with a view of ascertaining what we should best do to work in concert with them. By coöperation we could, it was thought, accomplish more and better work than by working independently, and we could assist the general survey by the contribution of observations we have already made.

So the writer, acting independently, wrote to Major J. W. Powell, Director of the United States Geological Survey, to ascertain what we had best do to secure the best work for our State. It was explained that we had been hammering away at the matter of getting a bill passed by the Legislature for a State Geological Survey for some years; that the people were in need of such a scientific work, that our resources might be developed, and the wasteful expenditure of capital in the blind search for minerals be avoided; that there was great interest in the matter, as manifested by the numerous schemes which have been before the Legislature for the purpose, but that we had been unable to accomplish anything as yet. But now, in view of the fact that the United States Geological Society intended to cover the entire national domain, and the topographical survey having been already begun in Kansas, that we, the Kansas Academy of Science, desired to know what we should do in order to coöperate with the Government work, that we might get the most benefit out of it for the people of the State.

To this communication a courteous reply was received from Major Powell, saying that the topographical survey of Kansas was progressing satisfactorily, six sheets of the atlas being in the hands of the engraver, and six more were ready for him. Kansas will thus have an accurate map. No geological work can be done without the topographic basis, and how soon this will follow he did not say. He will take pleasure in coöperating with the scientific men of the State in making a thorough geological survey. With the letter he also sent the volume, "On the Organization of the Scientific Work of the General Government," which is the testimony given by Major Powell before a Congressional commission in December, 1884, on the subject. This report is a perfect mine of information upon the much-mixed subject of the United States surveys in particular and of Government scientific work in general. To that volume I am indebted for such facts as are herewith submitted.

In the first place, be it understood once for all, the United States Geological Survey is not intended to take the place of State surveys, nor to do the work demanded of them by the interests of the people. While the topographical and geological work is thorough and elaborate, neither one is of sufficient minuteness to answer the local purpose for which such maps are used. But this survey should be followed and amplified by State work, which should proceed further and give more details upon enlarged maps. Some States—Pennsylvania, New Jersey, and Massachusetts, for instance—have made additional appropriations for the use of the United States Geological Survey, that that organization might make the maps on a large scale, and thereby give greater detail. The people of these States now have maps as accurate as the latest science can make them, and as elaborate as they will require for all purposes. The survey work is, of course, much better done than any State could afford

to do alone. The Director of the National Survey used all the available scientific material of these States to the best advantage; where the work already done is sufficiently good, it is used as a basis, and where in error it is corrected. As all topographic work heretofore done is in error, owing to the inaccuracy of old methods, all that needs to be entirely new work. Some of the geological work is good, but, being wrongly located, must be revised. So that it is to the advantage of the States in every way to have the work done by the national organization, as being better than they can do themselves.

After the work of the Government corps in the West, it was found that with their methods they could do more work for less money, than the State surveys of the East working by the old methods. So the Government survey was invited to work in the Eastern States, some of which had their entire maps made for them by the Government corps of trained observers and calculators. Pennsylvania has had the topographic work done by the Government survey, and will pay the expense of additional detail. Massachusetts began, years ago, to make a topographical survey, and has turned over all the material to the United States Geological Survey, for its working basis. This material is known as the "Borden triangulations." The Legislature appropriated \$40,000 for the use of the survey in giving them greater details on maps of larger scale.

The Government work had been begun in Massachusetts — just as it has been begun in Kansas — and the opportunity was seized to secure to the State the best possible map. Maine had a preliminary examination of her rocks made — much as Kansas has had — but made no survey nor maps. New York has had a partial triangulation made by State authority, but the geological survey has not constructed maps. In California a thorough topographical survey was made by Prof. Whitney, and the geological work followed upon that of course, because a topographical survey must precede the geological as a necessary preliminary. Much of the Government work in that State was done on that survey as a first basis.

Grand triangulations upon which the geodetic surveys of the States must rest, should be executed by the General Government, for interstate geodesy will depend for accurate basis and for uniformity and harmony upon the Government survey, which will cover a continent. All State, county, township and other boundaries should rest upon the national system for permanence, as well as the boundaries of estates, and the titles to property. Boundaries do not always appear in nature, but should be defined by unchangeable mathematics, based on the astronomical meridians.

The General Government requires accurate maps for its own purposes — military, political, fiscal, postal routes, etc., and they are necessary to legislation on a variety of subjects; the distribution of mineral wealth, forests, arable and desert lands, the relation of flood districts, drainage, areas, railroads and highways, etc. To these practical subjects must be added the use of maps to that large body of scientific men in every country, on whom the progress of that country depends, to whom accurate maps are indispensable.

It is part of the grand scheme of the national surveys that they shall be supplemented in all the States in which they work, by State surveys, to carry forward this work in greater detail. In fact, all Government work is of this nature. That is, it furnishes the exact scientific basis, and from that the States and individuals can elaborate the minutiae. And it is right that this should be so; for the general surveys cannot be burdened with the details of the various districts whose different requirements are infinite. This is also the theory of the Meteorological office and the Fish Commission, which furnish bases and material to be elaborated by workers in the details in all the States.

The economic part of geological surveying is a department which cannot for many reasons be done by a national organization; that must be done by the State surveys, and the mineral beds, etc., be properly located and described. Information relating to economic deposits must be furnished by the State surveys when demanded by the people. The general survey makes topographic maps, places on them the geologic formations, and discusses the relations of the iron, copper, coal, phosphates, etc., to the formations. Then the State survey comes in and fixes the values of the deposits, methods of development, and other questions of economic interest; upon this basis many States are reorganizing their surveys.

The surveying and map-making operations of the United States Government are divided into three departments, as follows:

I. The geodetic or coast survey.

II. The geological survey—including, as a necessary preliminary, the topographical work. And

III. The land surveys of the General Land Office.

1. The geodetic or coast survey does that surveying and platting of the coast and adjoining ocean which is necessary to make charts for the use of marines. This work has been carried on for a number of years, and the two coasts of our country are nearly completely charted. That is, the land and coast maps are nearly finished, but there is a continual need of the study of the ocean—the hydrographic work.

2. The geological survey has been referred to, and its work is familiar to every one. Its importance may be noted in the fact that the mineral products of the United States amount to \$450,000,000 annually. Surely there should be a scientific basis for this industry, and the topographic work is also important, in that it gives us accurate maps which are of use for many purposes.

Both geodetic and topographic surveying are first begun by the measuring of base lines. These base lines are scattered about 200 miles apart throughout the country, depending on favorable sites. They are four or five miles in length, and are measured many times, to secure the greatest possible accuracy, astronomic and telegraphic methods being used to obtain the latitude and longitude exactly. From these base lines the triangulation is expanded, the first triangles being small, those more remote much larger, the sides sometimes measuring thirty to fifty miles. The intervening country is then triangulated, to locate all objects desired to be noted on the map, and the extent of the measuring and the scale of the map determine the details of the work. The main difference between a geodetic and topographic survey is in the fact that the former is by far the most minute and exact, being primarily made for the purpose of ascertaining the shape of the surface of the earth. For this its methods are very much more refined than the topographic methods, which are intended for map-making only, which is a very different thing. There is no need, in the latter, of determining the location of a point within less than ten feet in 1,000, for such error would not show on an ordinary map. But in geodesy the error must not be one-tenth of that, for, by multiplying, it would become very serious. Geodesy is valuable also in cadastral surveying, or the bounding of private estates and properties, in that it provides unchangeable astronomical data.

The base line from which the triangulation of Kansas is now being carried on is located in southwest Missouri, and the adjoining three States. This is one of the five great base lines the geological survey has located on the national domain, and it would seem to become us to seize the opportunity, while the survey is working within our borders, to have the map made on a large scale, as other States have done, by paying an additional amount for the extra expense of placing minute features on the map. The United States survey, of course, locates all streams and all eleva-

tions, timber, etc., and the permanent cultural features, such as towns, railroads, etc.; but the less permanent cultural features, the minute natural features, the lesser boundaries, etc., it does not locate. The general geology is given on the maps, but not the minutiae which are necessary for economic purposes. These extra details the State should secure by paying for the additional expense of making maps of a larger scale, and it should be done by prompt action on the part of the Legislature.

It is interesting to note the exactness of the Government survey work, in that the average error of the geodetic work of the coast survey is not over one-half inch per mile, and the average error of the topographic work of the geological survey is not over six inches per mile; that is, in a line of twenty miles the error would be ten feet. That is the height of human accuracy, for such error cannot appear on any ordinary map, even of the larger scale.

The maps in the far West were constructed by the geological survey on a scale of four miles to the inch. But in the Eastern States in conjunction with the coast surveys, the scale is one mile to the inch, which shows all the minute natural and cultured features required. Such a map costs \$10 per square mile to survey, one-half being borne by the General Government, and one-half by the State. Such a map the State of Kansas needs and can easily afford for the benefits acquired. Extra minuteness in the geology will of course cost something additional besides, but only a trifle to this great State with such wonderful mineral resources. There is now enough capital being thrown away in any one year in the blind search for coal, iron, zinc and other minerals to pay for a good geological survey in connection with the national work. Why, the city of Topeka has voted \$15,000 for the purpose of boring a shaft to ascertain if a paying vein of coal does not underlie the city somewhere in the bowels of the earth. The experimental boring is to be made on the principle that the coal is sure to be found, if the money holds out to go deep enough. But the geologist knows that there are many factors to be considered in such an experiment, which only an exact and comprehensive survey can furnish. So capital is being wasted everywhere in the State.

3. The surveys of the General Land Office are made by chart and compass, without the least regard to scientific location. Townships are drawn upon paper and then staked out on the ground, beginning anywhere, and ending when it runs up against another party's survey. It seems amazing that there should have been no astronomic starting-point for these surveys, but such is the fact. They should have been founded as the cadastral surveys of other civilized countries are based—upon geodetic surveys; but it was not so done, and cannot now be remedied. Trouble has already arisen in regard to boundaries in many of the Eastern States, and much more difficulty and litigation will follow. The land surveying is performed by contract by private surveyors, being let to the lowest bidder. Anyone can readily appreciate what sort of work that would result in. The surveying was done by a party staking off a north-and-south meridian anywhere, and measuring off the mile-square sections from that. Where the plat of one party joined that of the next, fractions were introduced to fill up the space. But fractions also occur elsewhere, owing to errors necessarily made by the crude methods of measurement. But even if accurate and well done, it would be impossible to secure permanent boundaries, so necessary for deciding disputes, for the starting meridians are located without any reference whatever to the meridians of longitude, astronomically located at regular intervals and readily determined. So that if the accidental meridian of the land survey is lost, by the destruction of the stakes or corner-stones, it cannot be found again. If the land survey had been properly founded on a scientific survey, boundaries could be readily found and titles of all kinds of property in the West would be more secure. The coast survey, where it has mapped the coast and a narrow strip of adjoining land,

has made cadastral or estate survey on a minute scale, with all the exactness of geodesy. If the country of the West had been triangulated, even grossly, and the land survey made upon that basis, its work would have been much more reliable and permanent. The topographic and even the geodetic surveys of France and England preceded the cadastral, or estate, surveys of that country, so that all boundaries are exact, and all features permanently located. These maps need to be changed only as the cultural features change.

There is in Europe an international geodetic system which is uniform and mutually dependent. In this country there should be such an interstate system, and this we have in the topographic and geological survey of the General Government. Upon this or an accurate scientific basis it is intended that the States shall have their surveys, and elaborate the details as much as desired.

In view of these imperfectly presented facts, then, the final consideration is, what should the State of Kansas do to secure the best benefits from the United States survey within her borders? The reply is, briefly, that the Legislature should make an appropriation for the enlargement of the scale of the maps, in order that more details may be shown and the maps be made more generally useful for all scientific and economic purposes. Other States are now doing this, and having the Government survey do the work for them, for the reasons—to briefly recapitulate—that the survey is already organized and equipped, and has the best specialists in its permanent employ, and the work can be done with infinitely greater accuracy than by hastily-organized State surveys with political hindrances, and they can do the work much cheaper for the States than they can do it themselves, and will conduct the work with the uniform system of the whole country. The cost to the State of Kansas for the enlargement of the map would be from \$10 to \$15 per square mile for all the survey work. Not being mountainous, the expenses would be light, and the progress more rapid. Already the eastern third of the State is surveyed by the topographical corps on the Government scale of four miles to the inch, and if we wait until the entire State is covered the cost of resurveying for the large scale of one mile to the inch will be much greater. The smaller scale is all needed to base boundary surveys upon, which will in time save much trouble.

The State work of the national survey should be managed by a commission of scientific men, who would have cognizance and control of the work which the Director of the United States would execute for them. Such a commission as the President of the Kansas Academy of Science, the Secretary of the State Board of Agriculture, and the Superintendent of Mines, would be appropriate and capable.

The Academy should appoint a committee to take the matter under advisement, to correspond with the Directors of the United States Geological Survey as to methods of procedure for coöperation, and get it into shape to present to the Legislature. The Academy should further memorialize the Legislature to act promptly in the matter, for the workmen are upon our ground, and the opportunity is passing.

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## ON THE DESTRUCTION OF THE PASSIVITY OF IRON IN NITRIC ACID BY MAGNETIZATION.

BY EDWARD L. NICHOLS AND W. S. FRANKLIN,  
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### I.

During the winter of 1884-5, the authors of this paper were engaged in the investigation of chemical behavior of iron in the magnetic field. In the course of their experiments they had occasion to bring into the field of a small electro-magnet, a beaker containing powdered iron submerged in cold concentrated nitric acid,